IS 6297-4 (1974): Transformers and Inductors (Power, Audio, Pulse and Switching) for Electronic Equipment, Part 4: Pulse and Switching Transformers [LITD 5: Semiconductor and Other Electronic Components and Devices]

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Indian Standard

(Reaffirmed 2004)

SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART IV PULSE AND SWITCHING TRANSFORMERS

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SPECIFICATION FOR TRANSFORMERS AND INDUCTORS (POWER, AUDIO, PULSE AND SWITCHING) FOR ELECTRONIC EQUIPMENT

PART IV PULSE AND SWITCHING TRANSFORMERS

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PART IV PULSE AND SWITCHING TRANSFORMERS

0. FOREWORD

0.1 This Indian Standard (Part IV) was adopted by the Indian Standards Institution on 28 November 1974, after the draft finalized by the Transformers and Inductors for Electronic Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard lays down requirements for pulse and switching transformers intended for use in electronic equipments.

0.3 This standard is to be used in conjunction with IS : 6297 (Part I)-1971* which is a necessary adjunct. Should, however, any deviation occur between IS : 6297 (Part I)-1971* and this standard the provisions of the latter shall prevail.

0.4 It is recognized that in the case of components like pulse and switching transformers for electronic equipment, complete understanding of the requirements of the particular equipment is possible only if the indenting user gives details of all requirements. A list of points on which one should furnish the information at the time of enquiry or order has been included in Appendix A.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

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*Specification for transformers and inductors (power, audio, pulse and switching) for electronic equipment : Part I General requirements and tests.

†Rules for rounding off numerical values (*revised*).

1. SCOPE

1.1 This standard (Part IV) lays down the tests and requirements for pulse and switching transformers intended for use in electronic equipment.

1.2 The following transformers are covered by this standard:

a) Pulse transformers such as those used:
   1) in blocking oscillator applications;
   2) as isolation/coupling transformers;
   3) in thyristor triggering applications, etc; and
   4) in radar transmitters and similar equipments.

b) Switching transformers for transistor converter/inverter circuits.

1.3 The types not covered are the distinctly non-linear pulse transformers and inductors and magnetic amplifiers used in special applications such as:

a) those used in pulse forming networks, ferroresonant constant voltage transformer, magnetic pulse modulators, pulse magnetic amplifiers, magnetic frequency multipliers and dividers; and

b) those used in memory (storage) shift register, counting, switching and logic circuits.

2. TERMINOLOGY

2.0 For the purpose of this standard, in addition to the definitions given in IS:6297 (Part I)-1971*, the following shall apply.

2.1 The methods of measurement of a few important parameters together with the circuit set-up have been listed in Appendix C. Network for testing waveform parameters is given in Fig. 2.

2.1.1 *Pulse Rise Time* — The time interval between the instants at which the instantaneous amplitude first reaches specified lower and upper limits, namely, 10 percent and 90 percent of the peak pulse amplitude.

2.1.2 *Pulse Duration* — The time interval between the first and last instants at which the instantaneous amplitude reaches 50 percent of the peak pulse amplitude.

2.1.3 *Peak Pulse Amplitude* — The maximum absolute peak value of the pulse, excluding those portions considered to be unwanted or non-pertinent, such as spikes.

NOTE — Where such exclusions are made, it is desirable that the amplitude chosen be illustrated pictorially. One method of determining the peak pulse amplitude is shown in Fig. 2 in Appendix C. In this case, it is determined by the intersection of a line tangent to the leading edge of the pulse and a line tangent to the 'flat top' of the pulse.

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2.1.4 *Pulse Decay Time* — The time interval between the instants at which the instantaneous amplitude last reaches 90 percent, and next reaches 10 percent of the peak pulse amplitude.

2.1.5 *Crest Pulse Amplitude* — The maximum value of the pulse relative to the zero amplitude level.

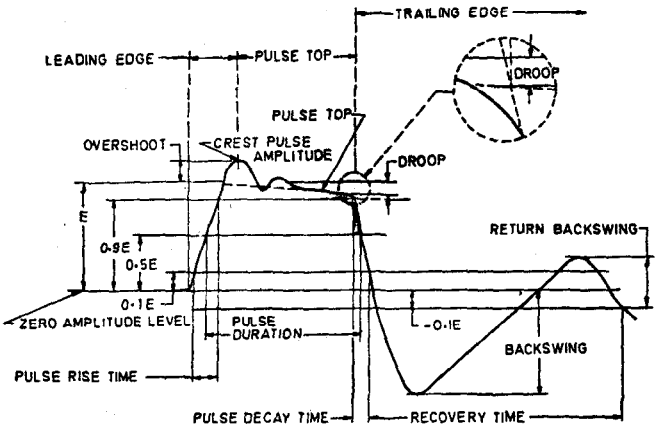
2.1.6 *Leading Edge* — That portion of the pulse in which the amplitude rises from zero to its crest pulse amplitude.

2.1.7 *Trailing Edge* — That portion of the pulse in which the amplitude descends from its value at the end of the pulse top to its ultimate zero level.

2.1.8 *Pulse Top* — Unless otherwise specified, the pulse top shall be the flat part of the pulse shown in Fig. 1.

2.1.9 *Droop* — Unless otherwise specified, droop is that displacement of the peak pulse amplitude shown in Fig. 1. Droop is expressed in volts or as a percentage of the peak pulse amplitude.

2.1.10 *Overshoot* — The amount by which the crest pulse amplitude exceeds the peak pulse amplitude. Overshoot is expressed in volts or as a percentage of the peak pulse amplitude.



E = Peak pulse amplitude

FIG. 1 PULSE WAVEFORM

2.1.11 *Backswing* — That portion of the trailing edge extending below the zero amplitude level. Backswing may be expressed in volts or as a percentage of the peak pulse amplitude.

2.1.12 *Return Backswing* — That portion of the trailing edge which has a polarity reversed to that of the backswing and occurs later in time than the backswing.

2.1.13 *Recovery Time* — That time interval between the time the trailing edge of the pulse first crosses a line representing 10 percent of the peak pulse amplitude and the time the pulse finally crosses either a positive or a negative line corresponding to 10 percent of the peak pulse amplitude.

2.2 Pulse Repetition Frequency — The number of times per second that a pulse is transmitted.

2.3 Duty Cycle — The product of the pulse duration and the pulse repetition frequency. This represents the time per second during which the power is applied.

2.4 Pulse Load Impedance — The ratio of the pulse voltage to the pulse current which flows when the pulse voltage is applied to the load.

NOTE — Unless otherwise specified, pulse voltage shall be the voltage *E* mentioned in Fig. 1.

2.5 Non-induced Voltage — A voltage which is applied uniformly to an entire winding in such a manner that no appreciable potential difference is induced along the winding. It may be direct voltage or alternating voltage.

NOTE — The filament voltage supplied to the load through a bifilar winding is one example of a non-induced voltage.

2.6 Non-transformed Current — A current which flows through a winding of a transformer but which is not due to a voltage induced in the transformer.

NOTE — The filament current in a bifilar winding is one example of a non-transformed current.

2.7 Bifilar Winding — Consists of two windings to be operated with no pulse potential between them. A bifilar winding is usually used to carry filament current to the heater of a tube whose cathode is driven by the transformer.

2.8 Trigger Winding — A winding added to a transformer for the purpose of supplying a relatively low voltage pulse to an external load, usually for synchronising purposes.

2.9 Graded Insulation — A method of construction wherein the insulation to ground is reduced more or less uniformly from the high potential end to the ground (or low potential) end. It is applicable to high voltage pulse transformers where windings are permanently grounded at one end or operated with one end permanently connected to a potential of 500 volts or less.

3. CATEGORIES AND GRADES

3.1 Categories — The transformers shall fall in any one of the categories mentioned in **3.1** of IS : 6297 (Part I)-1971*.

3.2 Grades — There shall be three grades of transformers depending on their insulation resistance values (*see* Insulation resistance test in Table 1).

4. MATERIALS, CONSTRUCTION AND WORKMANSHIP

4.1 The provision of **4** of IS:6297 (Part I)-1971* in general shall apply.

4.2 The forms of construction generally employed include in case of low voltage pulse transformers and switching transformers both flexible lead and printed wiring board designs with:

a) Thermoplastic sheath/epoxy dipped construction, or

b) Pre-moulded case in epoxy casting for packaging flexibility and printed wiring board designs, or

c) Hermetically sealed and encased in corrosion resistant non-magnetic cases with glass-to-metal seals on all terminals.

In the case of high voltage pulse transformers the transformers are:

a) in an oil filled case using high voltage ceramic terminals and with or without bellows to take care of expansion and contraction of oil under extremes of temperature, or

b) epoxy resin encapsulated.

5. MARKING

5.1 In addition to the markings specified in IS : 6297 (Part I)-1971*, the following information along with a diagram of windings shall be provided in the catalogue of the transformers as applicable and as much of it as possible shall be marked on the component also.

a) *Pulse Transformers*:

1) Primary open circuit inductance/effective pulse open circuit inductance,

2) Turns ratio,

3) Natural resonant frequencies/leakage inductance and distributed and coupling capacitances (as required),

4) dc resistance of windings,

5) Pulse duration (minimum and maximum),

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6) Pulse repetition frequency,
7) Maximum duty cycle,
8) Source impedance,
9) Load impedance,
10) Rated primary pulse voltage and current,
11) Rated secondary pulse voltage and current,
12) Maximum filament voltage and current in bifilar winding,
13) Grade, and
14) Category.

b) *Switching Transformers*:

1) Input volts dc,
2) Frequency of operation,
3) Turns ratio,
4) Secondary voltages and load currents (for switching-cum-output transformers), and
5) Associated application circuit with load details.

5.2 The pulse and switching transformers may also be marked with the ISI Certification Mark.

NOTE — The use of the ISI Certification Mark is governed by the provisions of the Indian Standards Institution (Certification Marks) Act and the Rules and Regulations made thereunder. The ISI Mark on products covered by an Indian Standard conveys the assurance that they have been produced to comply with the requirements of that standard under a well-defined system of inspection, testing and quality control which is devised and supervised by ISI and operated by the producer. ISI marked products are also continuously checked by ISI for conformity to that standard as a further safeguard. Details of conditions under which a licence for the use of the ISI Certification Mark may be granted to manufacturers or processors, may be obtained from the Indian Standards Institution.

6. TESTS

6.1 General Conditions for Tests — The provisions given in **6.1** of IS : 6297 (Part I)-1971* shall apply.

6.2 Classification of Tests

6.2.1 *Type Tests* — The provisions of **6.1.6.1** of IS : 6297 (Part I)-1971* shall apply.

6.2.1.1 *Number of samples* — The minimum number of samples for type test shall be 12.

6.2.1.2 *Sequence of type tests* — The sequence of type test for type approval shall be in accordance with Appendix A of IS : 6297 (Part I)-1971*.

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6.2.2 *Acceptance Tests* — The samples for acceptance tests shall be taken in accordance with **6.1.6.2** of IS : 6297 (Part I)-1971*. The following tests and all the routine tests (*see* **6.2.3**) shall constitute the acceptance tests:

Group A (for Non-destructive Tests)

a) Dimensions, if specified;
b) Bump test;
c) Vibration test; and
d) Applicable electrical tests:
   1) Natural resonant frequency/ leakage inductance and distributed/coupling capacitances (as specified);
   2) i) Pulse shape characteristics/ wave-form parameters (as specified),
      ii) Load voltage ratio and polarity (for high voltage pulse transformers);
   3) i) Functioning as part of application circuit (under specified conditions for all switching transformers),
      ii) Load voltage ratio and polarity (for switching-cum-step-up transformers);
   4) Induced high voltage test (for high voltage pulse transformers);
   5) Shielding (electrostatic) (for shielded types);
   6) Shielding (magnetic) (for shielded types); and
   7) Temperature rise.

Group B (for Destructive Tests)

a) Robustness of terminations,
b) Soldering, and
c) Climatic sequence.

6.2.3 *Routine Tests* — The following tests shall be carried out on each pulse and switching transformer as applicable:

a) Visual examination,
b) Sealing (for sealed types), and
c) Applicable electrical tests:
   1) dc resistance and continuity of winding,
   2) Turns ratio and polarity,
   3) Insulation resistance,
   4) Voltage proof (high voltage),

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5) Primary open circuit inductance/effective pulse open circuit inductance (as specified), and

6) Pulse shape characteristics/waveform parameters and voltage ratio (as specified).

7. TEST SCHEDULE

7.0 General — This test schedule specifies all tests and the order in which they shall be carried out as well as the requirements to be met with.

7.1 Test Schedule — The test schedule shall be as specified in Table 1.

NOTE 1 — The clause references, conditions of test and requirements specified are applicable for acceptance and routine tests also and the groupings are for the purpose of type tests only (*see* **6.2**).

NOTE 2 — Conditions of tests and the values for the requirements that are to be specified according to IS : 6297 (Part I)-1971* only are given in col 3 and 4 of Table 1. Other conditions and requirements of test are according to IS : 6297(Part I)-1971*.

TABLE 1 TEST SCHEDULE

(*Clauses* 3.2 and 7.1)

[*See also* Appendix A of IS : 6297 (Part I) - 1971*]

Sl No.	Test	Clause Reference of IS : 6297 (Part I)-1971*	Conditions of Test	Requirements
(1)	(2)	(3)	(4)	(5)
	All Samples (12 Samples)			
1.	Visual examination	6.3.1	—	—
2.	Dimensions	6.3.2	—	—
3.	Continuity of windings	6.2.1.1	—	—
4.	DC resistance of windings	6.2.1.2	—	The resistance value shall not differ from the stated value by more than specified below: For conductor size equal to or greater than 0·12 mm ±10% For conductor size below 0·12 mm ±15%
5.	Polarity	6.2.1.3	—	—
6.	Shielding:			
	a) Electrostatic shielding	6.2.1.4	—	—
	b) Magnetic shielding			

(*Continued*)

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TABLE 1 TEST SCHEDULE — *Contd*

Sl No.	Test	Clause Reference of IS : 6297 (Part I)-1971*	Conditions of Test	Requirements
(1)	(2)	(3)	(4)	(5)
7.	Temperature rise test (for load test details *see* **B-1.1** and **B-1.2**)	6.2.1.5	*See* Appendix B	As specified in IS : 6297 (Part I)-1971*
8.	Insulation resistance	6.2.1.6	—	For Grade 1 ≥ 5 000 MΩ For Grade 2 ≥ 1 000 MΩ For Grade 3 ≥ 100 MΩ
9.	Voltage proof (High voltage)	6.2.1.7	*See* Appendix B	—
10.	Induced high voltage test	6.2.2.5	*See* Appendix B	—
11.	Primary open circuit inductance/effective pulse open circuit inductance	6.2.3.1	*See* Appendix D	—
12.	Turns ratio	6.2.3.4, 6.2.4.1, and 6.2.5.3	*See* Appendix B	—
13.	Natural resonant frequencies/leakage inductance distributed and coupling capacitances	6.2.4.2 and 6.2.5.3	*See* Appendix B	As agreed to between the purchaser and the manufacturer
14.	Pulse shape characteristics/ waveform parameters	6.2.4.3	*See* Appendix C and Fig. 1	—
15.	Waveform parameters	—	*See* Appendix C	—
	The samples shall then be divided into four groups of three transformers each and the transformers in each group shall undergo the tests specified for each group.			
	Group 1			
16.	Hermetic sealing	6.3.5	—	—
17.	Soldering	6.3.4	—	—
18.	Robustness of terminations	6.3.3	—	—
19.	Bump	6.3.6	—	—
20.	Vibration	6.3.7	—	—
21.	Acceleration	6.3.8	—	—
22.	Shock	6.3.9	—	—
23.	Climatic sequence	6.4.1	—	—
	a) Dry heat	6.4.1.1	—	Insulation resistance value shall be as stated below: For Grade 1 ≥ 50 MΩ For Grade 2 ≥ 10 MΩ For Grade 3 Under consideration

(*Continued*)

TABLE 1 TEST SCHEDULE — *Contd*

Sl No.	Test	Clause Reference of IS : 6297 (Part I)-1971*	Conditions of Test	Requirements
(1)	(2)	(3)	(4)	(5)
	b) Damp heat (accelerated) (first cycle)	6.4.1.2	—	—
	c) Cold test	6.4.1.3	—	—
	d) Low air pressure	6.4.1.4	—	Insulation resistance value after 1½ hours recovery shall be as stated below: For Grade 1 ≥ 1 000 MΩ For Grade 2 ≥ 100 MΩ For Grade 3 ≥ 10 MΩ
	e) Damp heat (accelerated) (remaining cycles)	6.4.1.5	—	Insulation resistance value after 24 hours recovery shall be as stated below: For Grade 1 ≥ 2 500 MΩ For Grade 2 ≥ 500 MΩ For Grade 3 ≥ 50 MΩ
24.	Rapid change of temperature	6.4.3	—	After recovery, the minimum insulation resistance value shall be as stated below: For Grade 1 ≥ 1 000 MΩ For Grade 2 ≥ 100 MΩ For Grade 3 ≥ 10 MΩ
25.	Salt mist	6.5	—	—
	Group 2			
26.	Mould growth	6.6	—	—
	Group 3			
27.	Damp heat (long term exposure)	6.4.2	—	Insulation resistance value shall be as stated below: *After 1½ hours recovery* For Grade 1 ≥ 1 000 MΩ For Grade 2 ≥ 100 MΩ For Grade 3 ≥ 10 MΩ *After 24 hours recovery* For Grade 1 ≥ 2 500 MΩ For Grade 2 ≥ 500 MΩ For Grade 3 ≥ 50 MΩ
	Group 4			
28.	Endurance	6.8	—	Insulation resistance value shall be as stated below: For Grade 1 ≥ 2 500 MΩ For Grade 2 ≥ 500 MΩ For Grade 3 ≥ 50 MΩ

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APPENDIX A

(*Clause* 0.4)

INFORMATION TO BE GIVEN BY THE PURCHASER

A-1. The purchaser of the pulse/switching transformer shall furnish information on the following items as are applicable:

Pulse Transformer:

a) Grade;
b) Category;
c) Source impedance;
d) Load impedance;
e) Maximum pulse duration;
f) Minimum pulse duration;
g) Pulse repetition frequency;
h) Maximum duty cycle;
j) Primary pulse voltage and current;
k) Secondary pulse voltages and currents;
m) Turns ratio;
n) DC resistances of windings;
p) Natural resonant frequencies/leakage inductance/distributed and coupling capacitance requirements;
q) Maximum filament voltage and current in bifilar winding (for high voltage types only);
r) Circuit diagram of modulator and an accurate description of load/loads (for high voltage types only);
s) Magnitude, polarity and/or phase relationship of all non-induced voltages and currents for all windings where they occur;
t) Relative importance of and limitations on pulse rise time, overshoot, droop, fall time, backswing and return swing;
u) Unusual requirements or operating conditions such as intermittent operation (for high voltage types);
v) Special constructional features;
w) Conditions of operation (ambient temperature, altitude, vibration requirements, etc); and
y) Shielding requirements.

Switching transformer:

a) Application circuit;

b) Intended frequency of operation;

c) Input dc voltage;

d) Secondary voltages and currents including type of loads;

e) Grade and category;

f) Any other special requirements;

g) Special constructional features;

h) Conditions of operation (ambient temperature and altitude, vibration requirements, etc);

j) Shielding requirements; and

k) Regulation.

APPENDIX B

(*Clause* 7.1 *and* Table 1)

CONDITIONS FOR VARIOUS TESTS

B-1. LOAD TEST (AS APPLICABLE TO PULSE TRANSFORMERS, LV AND HV TYPES)

B-1.1 The transformer shall be operated at rated power, pulse length and duty cycle with actual operating load or one which simulates it as closely as possible. The pulse duration and pulse repetition rate for the test shall be determined by those which have the largest duty cycle. If the duty cycle is constant, the longest pulse duration operating condition shall be used. In the case of HV types, the source or modulator should simulate that for which the pulse transformer is designed as closely as possible.

The acceptability of the pulse shape shall be determined by inspection of the output pulse as viewed on a synchroscope. The load voltage ratios and polarity may also be checked in this test. The temperature rise test shall be performed on transformers rated at more than 0·8 watts average output.

B-1.2 Load Test (As Applicable to Switching/Switching-cum-Output Transformers for Transistor Inverters and Converters)—The switching transformers shall be operated as part of the application circuit at the oscillation frequency and from dc supplies and with loads as specified.

The oscillatory function and load voltages may be checked in this test. The temperature rise test shall be performed on all switching transformers and switching-cum-output transformers.

B-2. VOLTAGE PROOF/DIELECTRIC STRENGTH TESTS (AS APPLICABLE TO HV PULSE TRANSFORMERS)

B-2.0 This test is not applicable to transformers with windings designed to have one end or one point earthed/returned to low potential point.

B-2.1 A test potential, either dc or ac of commercial line frequency, shall be applied between each winding and the core or case for one minute. All windings not under test shall be grounded to the core or case. The peak test voltage used between each pair of windings (or between each winding and the case) shall be four times the working non-induced voltage between the two windings or between the winding and the case for voltages up to 500 volts, two times the working voltage plus 100 volts for voltages between 500 and 2 000 volts, and one and a half times the working voltage plus 2 000 volts for voltages above 2 000 volts.

B-2.2 In no case, except between the two parts of a bifilar winding, shall a test voltage lower than 700 volts be used. A minimum test voltage of 150 volts shall be used between the two parts of a bifilar winding.

B-3. INDUCED HIGH VOLTAGE TEST (AS APPLICABLE TO HV PULSE TRANSFORMERS)

B-3.1 Pulses of twice the rated pulse voltage and a minimum of one-fourth longest rated pulse duration shall be applied to the normal input winding. At least 25 percent of maximum PRF shall be used. The test potential shall be increased gradually (at the rate of approximately 2 kV per second) from zero to the specified value, maintained at this value for a period of one minute and decreased gradually to zero. The pulses shall be supplied by a modulator of adequate power and sufficiently good regulation characteristics to limit the magnitude of spikes or droop to less than 10 percent of the pulse voltage. For transformers to be operated in circuits were the applied voltage may actually rise to twice normal during abnormal load conditions, the test voltage shall be raised to two and a quarter times the rated pulse voltage.

NOTE — A load may be necessary when making this test.

APPENDIX C

(*Clauses* 2.1, 2.1.3 *and* Table 1)

METHODS OF MEASUREMENT OF WAVEFORM PARAMETERS

C-1. WAVEFORM PARAMETERS

C-1.1 Waveform parameters shall be measured as specified. For parameters not listed, any suitable means of measurement may be used. Unless otherwise specified, the network shown on Fig. 2 shall be used to determine the parameters.

C-2. PULSE RISE TIME

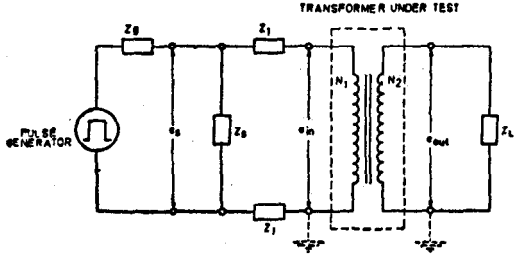
C-2.1 The method of measurement for the pulse rise time (*see* Fig. 3) shall be as follows:

a) Obtain a calibrated (time and amplitude) picture of the waveform including the pulse. Delineate the pulse by excluding those portions of the waveform determined to be unwanted or nonpertinent.

b) Draw the zero axis of the pulse.

c) Find the peak pulse amplitude.

d) Draw two lines parallel to the zero axis and spaced on each side of the zero axis by 90 percent, or other specified fraction, of the peak pulse amplitude and two parallel lines spaced on each side of the zero axis by 10 percent, or other specified fraction, of the peak pulse amplitude. The time interval between the first point of intersection of the pulse trace and either 10 percent line and the first point of intersection of the pulse trace and either 90 percent line is the pulse rise time.



Z_g = Source impedance
Z_s = Shunt impedance
Z_1 = Current limit and balance impedance
Z_L = Load impedance

FIG. 2 NET WORK FOR TESTING AND DETERMINING WAVEFORM PARAMETERS

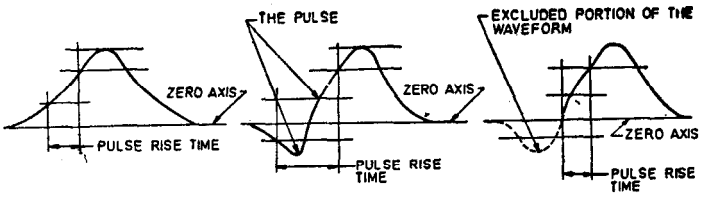


FIG. 3 EXAMPLES OF PULSE RISE TIME DETERMINATION

C-3. PULSE DURATION

C-3.1 The method of measurement for the pulse duration (*see* Fig. 4) shall be as follows:

a) Obtain a calibrated (time and amplitude) picture of the waveform including the pulse. Delineate the pulse by excluding those portions of the waveform determined to be unwanted or nonpertinent.

b) Draw the zero axis of the pulse.

c) Find the peak pulse amplitude.

d) Draw two lines parallel to the zero axis spaced on each side of the zero axis at 50 percent, or other specified fraction, of the peak pulse amplitude. The time interval between the first and last points of intersection of the pulse trace and either line is the pulse duration.

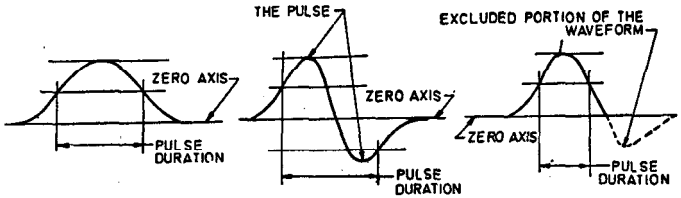


FIG. 4 EXAMPLES OF PULSE DURATION DETERMINATION

C-4. PEAK PULSE AMPLITUDE

C-4.1 The method of measurement for the peak pulse amplitude (*see* Fig. 5) shall be as follows:

a) Obtain a calibrated (time and amplitude) picture of the waveform including the pulse. Delineate the pulse by excluding those portions of the waveform determined to be unwanted or nonpertinent.

b) Draw the zero axis of the pulse.

c) Find the maximum departure of the pulse trace from the zero axis (regardless of polarity sign). This departure is the peak pulse amplitude.

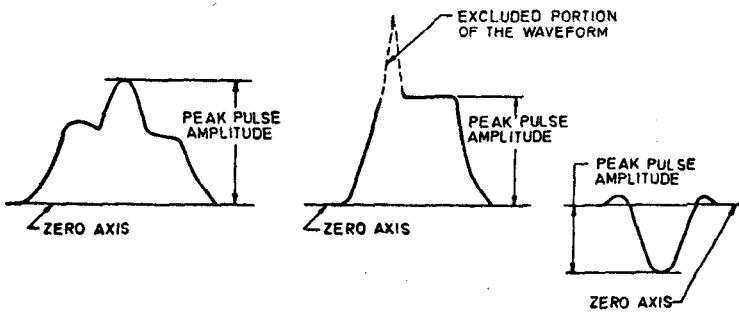


FIG. 5 EXAMPLES OF PEAK PULSE AMPLITUDE DETERMINATION

C-5. PULSE DECAY TIME

C-5.1 The method of measurement for the pulse decay time (*see* Fig. 6) shall be as follows:

a) Obtain a calibrated (time and amplitude) picture of the waveform including the pulse. Delineate the pulse by excluding those portions of the waveform determined to be unwanted or nonpertinent.

b) Draw the zero axis of the pulse.

c) Find the peak pulse amplitude.

d) Draw two lines parallel to the zero axis spaced on each side of zero axis by 90 percent or other specified fraction, of the peak pulse amplitude, and two parallel lines spaced on each side of zero axis by 10 percent or other specified fraction, of the peak pulse amplitude. The time interval between the last point of intersection of the pulse trace and either 90 percent line and the last point of intersection of the pulse trace and either 10 percent line is the pulse decay time.

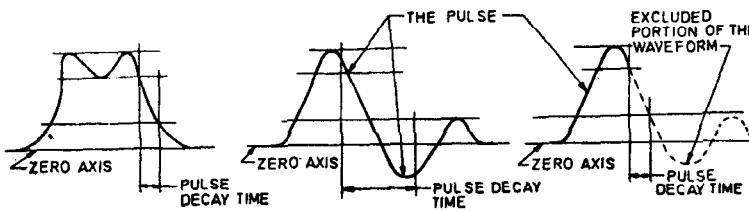


FIG. 6 EXAMPLES OF PULSE DECAY TIME DETERMINATION

APPENDIX D

(*Table* 1)

CONDITIONS OF TEST FOR PRIMARY OPEN-CIRCUIT INDUCTANCE AND EFFECTIVE PULSE OPEN-CIRCUIT INDUCTANCE

D-1. Primary open circuit inductance is measured at low levels, at frequencies equal to or less than one-tenth that of the natural resonant frequency.

D-2. Effective pulse open circuit inductance is measured by applying a voltage pulse from a pulse generator to the primary terminals in such a way as to simulate the actual operating conditions of the transformer with regard to voltage, pulse duration and reverse current and by measuring the exciting current on a synchroscope.

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